

Environmental Regulations and Industry Location:  
International and Domestic Evidence

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Abstract

This paper surveys the empirical literature on the sensitivity of investment to environmental regulations, both internationally and domestically within the U.S. Although more than twenty years of empirical research has been unable to show convincingly that stringent environmental standards deter investment or that weak regulations attract investment, many interest groups continue to argue that there is a strong relationship. This paper reviews some anecdotal evidence that local and national legislators take these effects seriously, along with the empirical evidence that fails to find them, and concludes by suggesting several potential explanations for this apparent logical inconsistency.

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"All my life I've seen the lads leaving . . . for the big smoke in London, Pittsburgh, Birmingham, and Chicago. It'd be better . . . if they stayed here and we imported the smoke."<sup>i</sup>

For nearly a quarter century, since industrialized nations began legislating and enforcing environmental laws with substantial compliance costs, critics of those regulations have protested that stringent environmental regulations force manufacturers of pollution-intensive products overseas. Jargon such as "ecodumping," "race to the bottom," and "competition in laxity" have been used to describe a feared consequence of this phenomenon, that different jurisdictions competing to attract international businesses would create pollution havens by lowering their environmental standards below socially efficient levels. Most of the theoretical economics literature on interjurisdictional competition concludes that without a long and somewhat unrealistic list of assumptions concerning the nature of the jurisdictions involved, such competition will indeed lead to inefficient outcomes.<sup>ii</sup> However, in contrast to the fears of environmentalists and the models of economic theorists, such competition does not seem to have occurred on a large scale. While there is some anecdotal evidence that political jurisdictions (national or sub-national) pass environmental laws with an eye toward attracting (or retaining) industry, there is no evidence that industry responds to differences in these laws in significant ways.

The literature on trade and the environment has evolved in two waves. The first set of research peaked during the late 1970s and seems to have been inspired by the growth of environmental regulations in industrialized nations during the early to mid-1970s. The second set has come more recently, apparently motivated by the debate over international trade agreements such as the North American Free Trade Agreement (NAFTA) and the Uruguay round of the General Agreement on Tariffs and Trade (GATT). The theory involved combines basic Heckscher-Ohlin trade theory with environmental

economic theory, and predicts that countries with lower environmental compliance costs have a competitive advantage in the production of pollution-intensive products and will export those goods.

The papers discussed below examine competitiveness from two different angles: trade patterns and industry location choice. These represent two ways of asking the same question. If an industry selling a product on a world market relocates from one country to another, the former country's net exports of that product will decline while the latter's will rise, all else being equal. Trade patterns, therefore, are merely the visible manifestation of industry relocation. Because trade data are more frequently and consistently available than industry location data, the trade pattern approach is more prevalent. One advantage of using trade data comes in helping to differentiate between economic growth based on the internal dynamics of each nation's economy and growth that comes at the expense of other nations. If the trade-off between economics and the environment is purely internal, there may be no cause for international concern. However, if economic growth within one country can be enhanced at other countries' expense by lowering environmental standards and attracting export industries, the result may be a "race to the bottom" in environmental standards. This is the fear that motivates much of the rhetoric surrounding environmental regulations and competitiveness.

### **International Environmental Regulations and Fear of Industrial Flight**

Whether some nations actively seek foreign investment by allowing themselves to become pollution havens is a question addressed by Leonard (1988). Leonard presents case studies of development strategies in four countries, of which only Ireland seems to have explicitly attempted to attract polluting industry. One official is quoted as saying "the permission to pollute may well be more valuable in economics terms than any Industrial Development Authority grants." In its defense, Ireland's high tolerance for pollution may come not only from its relative poverty, but also from its geography--an

island with high winds and ample rain. Nevertheless, it is this type of interjurisdictional regulatory competition that advocates of harmonization of pollution regulations would like to prevent.

An early attempt to harmonize international environmental regulations took place at the 1972 Stockholm Conference on the Human Environment. Industrialized countries looked to the United Nations to unify environmental rules to prevent industrial flight from nations with stringent standards, but developing countries argued that it was their turn to industrialize and that industrialized growth necessarily leads to pollution (Leonard, 1988). That same year, OECD countries passed the Polluter Pays Principle, which has an element of regulatory harmonization. It states that "the polluter should bear the cost of measures to reduce pollution." In a partial equilibrium framework, it does not really matter to efficiency whether the polluter pays to pollute or the state subsidizes pollution abatement.<sup>iii</sup> But without such an international agreement, pollution cleanup subsidies might provide a way to circumvent trade agreements and subsidize domestic industries. As Daly and Goodland (1994) argue, "nations that do not count the full environmental costs in the prices of their exports are in effect subsidizing those exports as surely as if they taxed their citizens and transferred the money to the exporters." The Polluter Pays Principle is merely an agreement among nations not to subsidize export industries in this way.

More recently, the debate over the United Nations Code of Conduct of Transnational Corporations focused on establishing a set of minimum standards for the treatment of multinational corporations (UN, 1988), although the section on environmental protection eventually passed contained little more than an insubstantial statement that they shall obey local laws. Even more recently, the debate over NAFTA has illustrated the dual fears that environmentalists and free trade advocates have about trade and the environment. Environmentalists worry that trade agreements will restrict domestic environmental laws, while free traders worry that environmental laws will serve as barriers to trade. The treaty, with its environmental side agreement, includes an affirmation of the right of each country to choose its own level of environmental protection and a general statement that NAFTA countries should not lower their health, safety, or environment standards to attract foreign investment.

Nations are not the only group that promulgates international guidelines. Industry associations have also done so. The International Chamber of Commerce passed its own environmental guidelines in 1981 and supported harmonizing pollution regulations worldwide (Leonard, 1988). One explanation for industries' interest in this issue is that "it is important for industry to keep a level playing field to avoid detrimental competition among its members as regards environmental standards" (UNCTAD, 1993). Presumably this form of collusion reduces the ill will an industry could generate by competing to pollute. An alternate explanation is that these associations may be controlled by companies wishing to protect existing plants in countries with stringent regulations. Most firms, however, seem to ignore the guidelines set by international political or industrial associations. Less than 20 percent of chemical companies surveyed adhere to the Chemical Manufacturers Association's "Responsible CARE Programme," while less than 10 percent of all surveyed firms say that they follow guidelines set by international organizations such as UNEP, OECD, etc. (UNCTAD, 1993). Still, the existence of these types of rules provides evidence that industry associations believe that international competition in pollution regulations is important.

In the U.S. the concern over international industrial flight dates back to some of the earliest national environmental legislation. The U.S. Federal Water Pollution Control Act of 1970 requires the Commerce Department to conduct a study of the competitive effect of environmental regulations on U.S. firms and requires the President to seek international agreements harmonizing water pollution standards.<sup>iv</sup>

In fact, the U.S. has entered into many international environmental treaties since 1970.<sup>v</sup> But because these treaties generally lack enforcement mechanisms, individual nations are often tempted to take unilateral action, often in the form of an environmental trade barrier. Walter Cronkite advocated a ban on products from any country with environmental standards less strict than our own in a 1980 letter to the New York Times, claiming that it would "protect both American industry and the environment."<sup>vi</sup> U.S. Senator Boren's (D-OK) proposed International Pollution Deterrence Act of 1991 would have imposed a tariff on imports of products from countries without "effective pollution controls." Had it

passed, the proposed tariff was to be equal to the costs that a foreign producer would have had to incur in order to comply with U.S. environmental standards. Morris Udall's (D-AZ) Copper Environmental Equalization Act, similar in intent, was defeated in 1977 and 1979.

The concern in the U.S. also crosses political party boundaries. In 1978 President Carter's chief trade negotiator, Robert Strauss, said that "we do not want the U.S. willingness to protect the environment and our workers to disadvantage the various U.S. producers."<sup>vii</sup> President Reagan's administration established the Task Force on Regulatory Relief, chaired by Vice President Bush, who when he became president then established the Council on Competitiveness, chaired by Vice President Quayle. Both groups' goals included limiting the extent to which domestic regulations reduced U.S. trade competitiveness. The Council on Competitiveness succeeded in blocking a number of environmentally oriented regulations, including a plan requiring municipal waste recycling, a regulation discouraging lead battery incineration, and a proposal limiting sulphur-dioxide emissions from a power plant near the Grand Canyon (GATT, 1992). Most recently, President Clinton's support for the NAFTA came with the caveat that environmental side agreements be negotiated with Mexico, and former California governor and presidential candidate Edmund G. Brown, Jr. opposed NAFTA, claiming that it would "create a race to the bottom in . . . environmental standards."<sup>viii</sup>

The evidence outlined above illustrates that many different interest groups, including politicians of various ideologies, environmental groups, and industry organizations, have expressed concern that industry location will be sensitive to environmental regulations. Some of these groups have even taken steps toward thwarting industry migration, such as proposing legislation, opposing free trade agreements, and promoting harmonization of international standards. The next section examines the empirical evidence to see how well founded their concerns may be.

### **Industry Location and International Environmental Regulations: Empirical Evidence**

Although there seems to be plenty of anecdotal evidence that policymakers and industry representatives take industrial flight seriously, there is only a limited amount of empirical evidence that industrial flight exists. For example, one of the most vocal opponents of NAFTA has been U.S. businessman-politician Ross Perot, whose opposition has been couched largely in terms of U.S. competitiveness. His organization catalyzed fears that free trade with Mexico could not be fair trade, given Mexico's lower wages and weaker standards for working conditions and pollution. In a now notorious remark, Perot likened the after-effect of the trade agreement to a "giant sucking sound" as U.S. jobs would disappear across the border. Yet six months after the agreement's start date, the Perot organization's newsletter, Afta-NAFTA Update, found meager evidence of disruptions due to NAFTA. The newsletter documents fewer than a dozen cases of firms expanding operations in Mexico while simultaneously contracting them in the U.S. The largest of these involves the glass maker PPG, which closed two plants in Pennsylvania, eliminating 560 jobs, hardly noticeable to the U.S. economy as a whole. In contrast, the newsletter also reports the incredible results of a survey conducted by the National Association of Purchasing Management: "17.1 percent of large U.S. companies plan to move operations to Mexico because of the NAFTA."<sup>ix</sup>

More objective evidence comes from the U.S. General Accounting Office, which in April 1991 reported on the relocation of wood furniture firms from Los Angeles to Mexico. Their survey found that from 1988 to 1990 between 11 and 28 of the 2675 wood furniture manufacturers in Los Angeles relocated at least some part of their operations to Mexico, affecting somewhere between 950 and 2500 jobs. In addition, between 3 and 100 firms relocated to other areas within the U.S. Of those relocating to Mexico 83 percent identified labor costs as a significant factor, while 78 percent identified pollution control costs.<sup>x</sup> While the number relocating appears quite small, the proportion of those that did move that

acknowledged doing so for environmental reasons is surprisingly large. Examining corporate records, it is generally difficult to find evidence that manufacturing facilities located to take advantage of lax environmental policies. While industrialists are quick to blame plant closures on tough regulations, nobody would want to poison community relations by saying that a new factory will be polluting more heavily than would be allowed elsewhere.

Direct evidence of this paradox was provided by Knögden (1979), who surveyed West German firms known to have made significant investments in developing countries (presumed to have less stringent environmental standards) since the early 1970s, when West Germany began to enforce strict environmental laws. In response to an open-ended question as to the companies' investment motives, only one company (a chemical manufacturer) volunteered that environmental regulations played a role, and only as the least important of the seven considerations it mentioned. Table 1 below reproduces responses to two of Knögden's survey questions. Respondents rated the importance of various investment motives on a scale from 1 (very important) to 5 (totally unimportant). The vast majority responded that environmental regulations are totally unimportant to the location of investment.

Table 1: West German firms' rating of the importance of environmental regulations to investment.

Investment Motive	Very Important 1	2	3	4	Totally Unimportant 5
	(%)	(%)	(%)	(%)	(%)
Strict environmental regulations in West Germany.	2	3	7	18	70
Especially lax environmental regulations in the host country.	2 <sup>xi</sup>	4	6	20	68

Source: Knögden (1979).

Knögden then looked further at the firms that answered these two questions with a 1 or a 2. These firms belonged primarily to the chemicals and primary and fabricated metals industries, and they tended to rate



all cost factors higher than the rest of the sample. Of those firms rating environmental factors "very important," the majority rated all other investment motives at 1, 2, or 3. The pattern of responses suggests that these industries are more sensitive to all types of local characteristics, perhaps because they are more geographically footloose.

A more recent survey of multinational corporations was conducted by the UN Conference on Trade and Development Programme on Transnational Corporations. The UN surveyed 794 corporations with sales over \$1 billion during the summer of 1990. Of these, 169 had responded by the end of 1991. Of the 169, most claimed that environmental, health, and safety practices overseas are determined by environmental regulations in their home countries. In general, differences across plants in their environmental practices seem to be affected more by home country regulations than host country regulations. Many of the companies surveyed claimed that they would not only comply with all local laws, but would write their own company policies if local laws were thought to be inadequate.

No matter how expertly assembled, survey evidence cannot prove that environmental regulations cause industrial flight or that their absence creates pollution havens, because there can be a large difference between what people (or firms) say they do in response to a survey and what they actually do. The difference may come about through intent or ignorance, but it means that convincing proof must come from analyzing data on what firms do rather than say.

Robison (1988) examines the evidence provided by trade patterns in an update of a study initially done by Walter (1973).<sup>xii</sup> He compares U.S. pollution abatement costs by industry for U.S. imports and exports, and finds that the ratio of abatement costs per dollar of value added for imports relative to exports rose from 1.15 in 1973 to 1.39 in 1982. In other words, goods imported into the U.S. are increasingly those goods that face high pollution abatement costs in the U.S. For trade with Canada, which has similarly strict laws, the abatement cost ratio has not changed over this period. Robison infers that environmental regulations are causing the U.S. to become less competitive in pollution-intensive products relative to countries with less stringent regulations. He goes so far as to estimate that an increase

in U.S. environmental compliance costs that led to a 1 percent increase in U.S. total costs would reduce the net value of U.S. trade by 0.67 percent. (This would have to be a very large increase in compliance costs, since they make up a small fraction of total costs.) The estimate represents an upper bound, since it assumes that all of the environmental control costs pass through to the product price, and it abstracts away from any general equilibrium effects. So even if Robison is correct that the U.S. is losing competitive advantage in pollution-intensive products, the trade effects he reports appear negligible.

Many of the papers in this literature begin with the assumption (often implicit) that developing nations have a competitive advantage in production of pollution-intensive products.<sup>xiii</sup> Their advantage could come from several sources. They may have greater physical capacities to absorb or assimilate pollution, or they may have environmental regulations with compliance costs that are lower than those of industrialized countries. Pearson (1987) suggests that "sketchy evidence on physical attributes such as level and seasonal distribution of rainfall, river discharge per unit of land surface, and variability of river flows . . . as well as on soil types and structures, suggests that developing countries have a lower inherent physical capacity ... to tolerate environmental stress." Thus it is more likely that developing countries' environmental competitive advantage, if they have one, stems from their weaker environmental laws. These weaker regulations may be a result of the fact that developing countries' citizens value the environment less, are poorer and cannot afford as much environmental quality as their wealthier counterparts, or simply do not have the administrative ability to monitor and enforce sophisticated regulations.

Leonard (1988) assumes that developing countries have lower standards and defines pollution-intensive industries in terms of spending on pollution abatement capital by U.S. plants. Of the four costliest industries, Leonard focuses on two in particular, the mineral processing and chemical industries. If U.S. pollution regulations are pushing these industries overseas, Leonard argues, there are four effects that should be discernible in aggregate international data: (1) The polluting sectors will be increasing their foreign direct investment (FDI) faster than other sectors, (2) Developing countries will be receiving

an increasing fraction of FDI in these industries, (3) U.S. imports of these products will be increasing faster than imports of other products, and (4) An increasing fraction of these imports will be coming from developing countries. Leonard finds little or no evidence that any of these changes has taken place. The closest he comes is to show that U.S. capital expenditures in the chemicals and mineral processing industries have increased more in developing countries than in industrialized countries during the 1970s. However, the vast majority of these industries' capital expenditures abroad still occur in other industrialized countries.

A previous study by the same author, Leonard (1984), asks the same set of questions using more disaggregate industry definitions. He finds that for three specific sets of industries, stringent U.S. laws seem to have pushed new investment overseas. The three are (1) manufacturers of very toxic, dangerous, or carcinogenic products such as asbestos, arsenic trioxide, benzidine based dyes, and some pesticides, (2) some metal processing industries such as copper, zinc, and lead (though this shift may be due to a combination of changes in mineral availability and some countries' requirements that minerals mined there be processed domestically), and (3) manufacturers of some organic chemicals that are intermediate products. Never, however, was Leonard able to find evidence that a healthy domestic industry, for which domestic demand was growing and U.S. producers maintained technological competitiveness, was pushed abroad by stringent domestic environmental regulations.

Low and Yeats (1992) also use developing countries as a proxy for the set of countries with weak environmental regulations and examine trade in pollution-intensive industries (iron and steel, nonferrous metals, refined petroleum, metal manufactures, and paper goods). Their data, presented in table 2 below, show that developing countries, roughly categorized, have gained a greater share of total world exports of pollution-intensive products, relative to other products and relative to industrialized countries. This provides rough empirical evidence of a pollution haven effect, but it does not prove its existence. In fact, industrialized countries continue to be the largest exporters of these polluting goods, by far. Of the top 25 exporters of Low and Yeats' "dirty" products, accounting for 85 percent of world trade in those products,

only eight are not OECD nations. It is also true that Low and Yeats make no claims as to the cause of the shift they describe, which could well be due to changes in labor costs, natural resource availability, or different phases of the cycle of industrialization. Low and Yeats acknowledge that the observed patterns are "unlikely to be adequately explained by environmental policy" alone.

Table 2: "Dirty" products as a percent of total exports.

	1965	1988
World	18.9%	15.7%
EEC(10)	19.9	16.1
N. America	18.5	14.2
E. Europe	21.6	27.6
Latin America	17.0	20.9
SE Asia	11.4	10.8
W Asia	9.2	13.4

Source: Low and Yeats (1992).

In a related piece, Low (1992) examines U.S.-Mexican trade for evidence that increases in U.S. environmental standards have caused industry to relocate to Mexico. He looks at the 48 industries that spend the most on pollution abatement in the U.S. These 48 industries accounted for 12 percent of Mexico's exports to the U.S., but these exports were growing at 9 percent annually compared to 3 percent for all exports. Although this may provide evidence of industrial flight, Low calculates that raising Mexico's pollution abatement costs to the level of the U.S. would add 0.6 percent of the costs of the imported products, and would result in at most a 2 percent drop in Mexican export earnings. So Low concludes, like Robison, that even if these environmental trade effects exist, they are very small.

Grossman and Krueger (1991) also look at U.S.-Mexico trade patterns. They model U.S. imports from Mexico by industry as a function of factor shares, U.S. effective tariff rates, and U.S. pollution abatement costs:

$$\left( \frac{\text{U.S. imports from Mex.}}{\text{Total U.S. shipments}} \right) - .028 \frac{(\text{.008})}{(\text{.016})} \bullet \left( \begin{array}{c} \text{skilled} \\ \text{labor} \end{array} \right) - .024 \bullet \left( \begin{array}{c} \text{capital} \end{array} \right) \\ - .002 \bullet \left( \begin{array}{c} \text{tariff} \end{array} \right) + .014 \bullet \left( \begin{array}{c} \text{pollution} \\ \text{abatement costs} \end{array} \right)$$

$$\begin{aligned} n &= 135 \\ R^2 &= .127 \\ &\text{significant at 5\%.} \end{aligned}$$

The results indicate that the U.S. imports from Mexico goods that use fewer skilled workers and less physical capital. Although the coefficient on U.S. pollution abatement costs is positive, as would be predicted by industrial flight from pollution regulations, it is both quantitatively and statistically insignificant. Based on this result, and those from similar specifications, Grossman and Krueger conclude that differences between the U.S. and Mexico's environmental regulations "play at most a minor role in guiding intersectoral resource allocations."

Several economists at the World Bank (Lucas, et al., 1992; Birdsall and Wheeler, 1992) have taken a different approach to examining industrial flight to pollution havens, using data from the U.S. Environmental Protection Agency's Toxics Release Inventory (TRI) merged with the Census of Manufactures. The TRI has, since 1987, reported plant-level emissions of each of over 300 toxic chemicals into various environmental media. Lucas, et al. used human risk-weighted indices of the various chemicals to compile a general index of "toxic intensity" for each of 37 industries. Birdsall and Wheeler note that the toxic intensity of a country as a whole can be described by the following simple equation:

$$\left( \frac{\text{Industrial Pollution}}{\text{GDP}} \right) - \left( \frac{\text{Value Added by All Industry}}{\text{GDP}} \right) \\ \times \left( \frac{\text{Value Added by Polluting Industry}}{\text{Value Added by All Industry}} \right) \times \left( \frac{\text{Industrial Pollution}}{\text{Value Added by Polluting Industry}} \right) .$$

The first term on the right-hand side is probably a function of a country's stage of economic development, and the third term may depend on the country's pollution regulations. The second term on the right-hand side is Lucas, et.al.'s index of national toxic intensity and is of principal interest to Birdsall and Wheeler. It measures the amount of pollution-intensive industry that a given country attracts, as measured by its toxic intensity in the U.S., as a fraction of that country's total industry. It is a weak measure of overall national toxic intensity, as it ignores the other two terms and is purely a product of the country's mix of industry, not its pollution standards. Nevertheless, it remains a decent measure of the type of industry that forms each country's industrial base.

The primary question asked by Birdsall and Wheeler is whether developing countries with more open trade policies attract more pollution-intensive industry. They regress the change in their toxic intensity measure on per capita income, the growth in per capita income, and an interaction between per capita income growth and an index of trade policy openness,<sup>xiv</sup> all in logs, for each of the 25 Latin American countries from 1960 to 1988. The results include negative and statistically significant coefficients on the log of per capita income and the change in per capita income. This suggests that wealthier countries, and those that are growing faster, have cleaner industries, and is consistent with many economists' expectations regarding development paths. Two dummy variables for the 1970s and 1980s, interacted with the logarithm of income growth, turn out to be positive and significant, which Birdsall and Wheeler argue shows that "Latin American growth rates of toxic intensity were generally higher (at each income level) after OECD environmental regulation became stricter." This appears to be a strong conclusion to draw from a simple dummy variable. The coefficient on the interaction between the 1980s dummy variable and the Dollar index of openness is positive and marginally statistically significant

( $t=1.87$ ), suggesting that more open economies attract less pollution-intensive industry and that more closed economies (with higher values of the Dollar index) have dirtier industries. The conclusions drawn by Birdsall and Wheeler are thus the opposite of those claimed by many environmentalists, who worry that open trade leads to environmental degradation overseas, and by the representatives of labor and manufacturing interests in industrialized nations, who worry that open trade leads to the creation of pollution havens abroad and industrial flight from more stringent regulations. Birdsall and Wheeler found that it is the more protectionist economies of Latin America whose industries are most pollution-intensive.

All of the studies discussed above use aggregate trade or FDI data to attempt to discern evidence of industrial flight from pollution regulations and acknowledge that they merely seek support for the effect. Proof of the effect would require controlling for all of the other factors that are likely to alter international patterns of trade and investment. The general lack of a shift of polluting industries toward developing countries does not prove the absence of a deterring effect of environmental regulations any more than evidence of such a shift would have proved the existence of a deterring effect. As Leonard (1988) puts it, "the real-world environment in which firms make long-term trade and investment decisions is not a Heckscher-Ohlin world, and all other things are never equal." Although statistical techniques for holding "all else equal" have been readily available for a long time, and although these techniques have been applied in the search for domestic evidence of interjurisdictional effects of environmental regulations (discussed below), few studies have attempted to do so on an international level, largely due to the difficulty inherent in comparing regulations and factor costs across international boundaries.

Of the recent studies of the effects of environmental regulations on trade patterns, Tobey (1990) is unique in attempting to control for other factors that may explain changes in these patterns. Tobey examines trade in 24 products (three-digit SIC codes) for which pollution abatement costs in 1977 in the U.S. exceeded 1.85 percent of total costs. These pollution intensive industries included subsets of 5 commodity groups: mining, primary iron and steel, primary nonferrous metals, paper and pulp, and

chemicals. To measure environmental regulatory stringency across countries, Tobey uses a 1976 study conducted by the United Nations Conference on Trade and Development (UNCTAD) cited by Walter and Ugelow (1979) that rates the environmental policies of about 40 countries on a scale from 1 (strict) to 7 (tolerant).<sup>xv</sup> He then estimates the following regression across countries for each of the 5 commodity groups separately:

$$\text{Net Exports} = \alpha + \beta V + \gamma E + \mu ,$$

where  $V$  is a vector of eleven country-specific factor endowments (labor, capital, minerals, etc.) and  $E$  is the UNCTAD index of regulatory stringency. The resulting estimates of the coefficient  $\gamma$  are never statistically significant in any of the specifications that Tobey tests. Tobey's interpretation is that "the magnitude of environmental expenditures in countries with stringent environmental policies [is] not sufficiently large to cause a noticeable effect." However the coefficients of  $V$ , the resource endowments of the countries, do not have a sensible pattern either (though perhaps this is due to the fact that the *quantities* of those factors may be less important than their *prices* in determining business locations). Of the 55 coefficients presented (11 resources and 5 commodity groups) 5 of the resource coefficients are negative, 7 are positive, and the remaining 43 are statistically insignificant. An alternative explanation for this model's estimated zero effect of regulations may be that the data are insufficient to answer the question.

All of the international studies of environmental regulations and competitiveness suffer from one or both of two major problems. They lack information about relative environmental compliance costs, and/or they rely on aggregate data. The dearth of information on relative compliance costs is partly because there are no good data on these costs, especially outside the OECD. As a result, most of the studies simply look for patterns in foreign direct investment, trade flows, or economic growth that would indicate sensitivity to environmental regulations, without trying to isolate the effect of environmental regulations by controlling for other factors that would affect those patterns. Only Tobey (1990) uses a ranking of countries' environmental standard stringency to try to control for other country characteristics.



And even Tobey's results are unsatisfactory because the UNCTAD ranking is subjective and ordinal, and because Tobey finds that environmental endowments are no worse predictors of net exports than are other factors.

The problem faced by all of the international studies using aggregate trade or FDI data to measure competitiveness is that the aggregate data represent the net changes caused by the births of new plants, the expansions and contractions of existing plants, and plant closures, some of which are due to changes in countries' own consumption patterns, and each of which can be expected to react differently to various environmental regulations. Many environmental regulations, for example, consist of "new source performance standards" that only apply to new firms. These standards effectively raise barriers to entry that favor existing older, often more labor-intensive plants. Using data that include all investment in a study of the consequences of regulations may conceal effects that work in opposite directions. Consequently, to isolate the effects of regulation on location, it is necessary to use establishment-level data. One solution for the lack of international data on specific industrial location decisions and on relative pollution abatement costs is to study industrial location within a given country. An obvious choice for such an empirical test is the United States, because of the data available, the stringency of its regulations, and the high degree of variation in those regulations across the 50 states.

### **Domestic Environmental Regulations in the U.S. and Fear of Industrial Flight**

Before 1970, local governments in the U.S. (states, counties and municipalities) were primarily responsible for environmental regulations (Portney, 1990). The situation changed in 1970, with the passage of the National Environmental Protection Act and the Clean Air Act, and the establishment of the Environmental Protection Agency and the Council on Environmental Quality. This federal involvement was motivated in part by congressional impatience over the lack of local progress, by public activism (notably the first Earth Day, in 1970), and by the fear that local jurisdictions would compete among themselves to attract industry by delaying the implementation of pollution control measures. Grounds for this last fear can be found in the statements of Louisiana Governor Edwin Edwards:

We have . . . taken the position that the need for . . . stimulation to our economy justified . . . serious tradeoffs, where the environment became either totally or partially damaged. None of us . . . in positions of authority in the state apologize for that. We did what we thought was best for the people and the economy of Louisiana. We accommodated industry where we thought we could in order to get the jobs and the development, and in some instances we knowingly and advisedly accepted environmental tradeoffs.<sup>xvi</sup> More systematic evidence that states use environmental regulations as competitive tools was

provided by Pashigian (1985), who examined the congressional vote on the 1977 Prevention of Significant Deterioration (PSD) amendment to the Clean Air Act. The PSD amendment modified the national ambient air quality rules to prevent the air quality of many clean jurisdictions from deteriorating to the level of the minimum national standards. The amendment was most popular among representatives from Northeastern states whose air quality failed to attain the national standards. Pashigian surmised that these representatives hoped that the PSD amendment would prevent industry from relocating to attainment regions to avoid compliance costs necessary in non-attainment areas. In addition, both the 1970 Clean Air Act and the 1977 Clean Water Act were designed, in part, to mitigate the chance that interjurisdictional competition would create pollution havens in states with lenient standards or cause industrial flight from states with stringent standards (Portney, 1990).

As with the international situation, there is ample evidence that policymakers and various interest groups take seriously the threat that environmental regulations will cause industry to locate in jurisdictions with the least stringent regulations. The next section reviews the empirical evidence as to the importance of this threat from a domestic perspective.

### **Industry Location and U.S. State Environmental Regulations: Empirical Evidence**

Direct evidence of firms relocating within the U.S. to avoid environmental regulations is, like the international evidence, difficult to find. Again, however, there are plenty of anecdotes. The California Business Roundtable claims that because of California's high business taxes and stringent environmental regulations, one-fourth of the state's manufacturers plan to relocate.<sup>xvii</sup> Commenting on New Jersey's (now amended) version of the federal "Superfund" law, the chief of a large manufacturing firm threatened "we just won't ever open a plant in New Jersey again" (Lyne, 1985).

Early surveys (before 1970) of U.S. factory managers involved in plant site choice neglected even to ask about environmental regulations (Mueller and Morgan, 1969; Greenhut and Colberg, 1969; U.S. Census, 1973). Most of the more recent surveys concluded that environmental regulations matter little to the locations of manufacturing plants, yet a few did find numerous respondents who claimed that environmental regulations affected their location choice (Wintner, 1982; Lyne, 1990). Comparing responses across these studies is difficult because they differ in scope and methodology. Some ask open-ended questions about factors potentially influencing location, while others ask respondents to rank a preselected list of factors. A sampling of such surveys is presented in table 3 below. One survey was performed fairly consistently during the early 1980s by Alexander Grant and Co., a consulting firm specializing in manufacturing plant siting. Their annually published survey of business climates in the 48 contiguous U.S. states relies on interviews with several dozen state manufacturing associations. The associations rate more than twenty state characteristics as to their importance in determining a state's

attractiveness to business. The ratings are expressed as percentages, summing to 100 percent.

Environmental control costs consistently appear two-thirds of the way down the list, at approximately 4 percent. Leaders include energy costs at 8 percent and wages at 7 percent.<sup>xviii</sup>

Table 3: Surveys of the importance of environmental regulations to plant location in the U.S.

Survey	Sample	Result
Epping (1986)	Survey of manufacturers (late 1970s) that located facilities 1958-77.	"Favorable pollution laws" ranked 43rd to 47th, out of 84 location factors presented.
Fortune (1977)	<u>Fortune's</u> 1977 survey of 1000 largest U.S. corporations.	Eleven percent ranked state or local environmental regulations among top 5 factors.
Schmenner (1982)	Sample of Dun & Bradstreet data for new Fortune 500 branch plants opening 1972-1978.	Environmental concerns not among the top 6 items mentioned.
Wintner (1982)	Conference Board survey of 68 urban manufacturing firms.	Twenty-nine (43%) mentioned environmental and pollution control regulations as a factor in location choice.
Stafford (1985)	Interviews and questionnaire responses of 162 branch plants built in the late 1970s and early 1980s.	"Environmental regulations are not a major factor," but more important than in 1970. When only self-described "less clean" plants were examined, environmental regulations were "of mid-level importance."
Alexander Grant (various years)	Surveys of industry associations.	Environmental compliance costs given an average weight of below 4%, though growing slightly over time.
Lyne (1990)	<u>Site Selection</u> magazine's 1990 survey of corporate real estate executives.	Asked to pick 3 of 12 factors affecting location choice, 42% of executives selected "state clean air legislation."

Potentially more satisfying are the empirical studies that examine the statistical evidence using data on state characteristics. Because of the limited availability of establishment-level data on new plant locations, most such work has used aggregate data on economic growth, employment changes, etc. One of the largest such studies was conducted by the Conservation Foundation (Duerksen, 1983) and was

motivated by several well-publicized cases of interstate industry movement allegedly provoked by environmental regulations (Chapman and Walker, 1991). The study examined changes in industrial employment among states during the 1970s. States that gained employment relative to the national average had more lax environmental standards than states that lost employment, though this difference was statistically insignificant and even smaller for pollution-intensive industries.

Duffy-Deno (1992) regresses total employment and total earnings (for all manufacturing industries) on a list of regional characteristics, including total pollution abatement costs, for 63 metropolitan areas from 1974 through 1982. Not surprisingly, given that he looks at aggregate employment and earnings for all industries, he finds that the coefficient on abatement costs per dollar of value added has statistically and economically insignificant coefficients. The exception appears when Duffy-Deno divides the sample into sun belt and frost belt cities, and runs the models separately for the two samples. Then the coefficients on abatement costs are statistically significant and negative for the frost belt sample, and remain insignificant for the sun belt. Yet even the frost belt coefficient remains tiny. The frost belt locations that have 10 percent higher pollution abatement costs are predicted to have manufacturing employment that is 1.05 percent lower, or overall employment that is 0.27 percent lower.

Crandall (1993) obtains a similar result using data on states rather than SMSAs. Crandall regresses employment growth on state characteristics, including annual state-wide pollution abatement operating costs divided by gross state manufacturing output. He concludes from the statistically insignificant coefficients on this measure that compliance costs do not have a "measurable effect on the regional distribution of manufacturing employment."

For the same reasons as in the international studies, using aggregate data may mask the true effects of environmental regulations on industry location. The primary obstacle to studying plant location decisions directly has been the inaccessibility of high-quality establishment-level data. Three studies have used extracts of the Dun & Bradstreet data<sup>xix</sup> to examine this relationship between industry growth

and environmental regulations: Bartik (1988), McConnell and Schwab (1990), and Crandall (1993).

None found significant or strong effects of variations in environmental regulations on location choice.

The Bartik paper uses McFadden's (1974) conditional logit model to predict the locations chosen by branch plants of Fortune 500 companies between 1972 and 1978. Its conclusion supports "the prevailing wisdom that environmental variables have only small effects on business locations." The McConnell and Schwab paper uses the conditional logit model and Dun & Bradstreet data on SIC code 3711, vehicle assembly. These plants, while painting cars and trucks, emit volatile organic compounds that contribute to urban ozone (smog). As a measure of regional environmental stringency, McConnell and Schwab use a series of dummy variables for whether or not the county chosen meets federal ambient ozone standards.<sup>xx</sup> They find significant coefficients only for those counties that are extremely far out of compliance: at the time Houston, Los Angeles, and Milwaukee. This finding is closer in spirit to an anecdote than a general conclusion: A particular industry, with a particular pollution problem, appears deterred from three specific cities.<sup>xxi</sup>

Crandall uses the Dun & Bradstreet data to disaggregate employment changes due to new plants, plant expansions, plant contractions, and plant closures. As a measure of regulatory stringency, Crandall uses total state-wide pollution abatement operating costs, divided by gross state manufacturing output. He finds that plant start-ups and closures are unresponsive to compliance costs, but warns against the conclusion that environmental policy does not affect plant openings, because compliance costs from plants deterred from opening are by definition zero. In other words, Crandall is justifiably concerned about the nature of his proxy for environmental stringency: States may have low pollution abatement costs because they have stringent regulations and polluting industries choose to locate elsewhere.

A common theme running through much of the previous work is that studying location choice in detail requires access to establishment-level microeconomic data, and that such data are either expensive, of poor quality, or not publicly available. Schmenner (1982), Bartik (1988), and Crandall (1993) noted the suitability of the Census of Manufactures, which is used by Levinson (1994) to examine the location

decisions of U.S. manufacturing establishments between 1982 and 1987. Levinson tests a number of measures of state environmental standard stringency, including subjective indices composed by environmental groups, a measure of state monitoring and enforcement effort, and an index created from plant-level pollution abatement expenditure data. He uses the conditional logit model used by Bartik and by McConnell and Schwab, and concludes similarly that environmental regulatory stringency does not have a significant effect, either statistically or economically, on manufacturer locations.

Finally, in a paper that links this domestic literature to the international papers discussed above, Freidman, et. al. (1992) use establishment-level data on the planned plant locations by foreign-owned firms within the U.S. Like Bartik, McConnell and Schwab, and Levinson, they use McFadden's conditional logit model to fit the choice of state on various state characteristics. In one of their specifications, they include total pollution abatement capital expenditure per dollar of gross state product from manufacturing. Although the estimated coefficient is statistically insignificant, that may be a product of the fact that the measure of stringency is its nominal incidence, includes only direct capital expenditures, and does not control for the industrial composition of the state. Nevertheless their conclusion supports that made by the literature on domestic firms, that plant locations appear unaffected by environmental compliance costs.

Table 4 presents representative specifications from each of the 4 studies that use establishment-level data and McFadden's conditional logit model to study the effect of local characteristics, including environmental regulations, on plant site choice. Although the results are not directly comparable, because they use different samples of plants, independent variables, and measures of environmental standard stringency, they consistently conclude that environmental regulations do not significantly affect site choice.

[Table 4 about here.]

The conclusions of both the international and domestic studies of industry location are that environmental regulations do not deter investment to any statistically or economically significant degree. Most authors are careful to note the limitations of their individual research, and to place caveats on their counter-intuitive conclusions that stringent regulations do not deter plants nor do lax regulations attract them. But the literature as a whole presents fairly compelling evidence across a broad range of industries, time periods, and econometric specifications, that regulations do not matter to site choice. The natural follow-up question is why not?

### **Explanations for the Absence of Evidence of Industrial Flight**

The literature surveyed above is almost unanimous in its conclusion that environmental regulations have not affected interjurisdictional trade or the location decisions of manufacturers. Where studies have found statistically significant effects of these regulations, the effects are always quite small. Yet, despite more than twenty years of these types of empirical studies, politicians and interest groups of various types continue to debate the issue of "jobs versus the environment." The fear of industrial flight has been and continues to be used by coalitions within both industrialized and developing nations as an argument in favor of postponing the imposition of stringent pollution regulations (Pearson 1987). The explanations for this gap between the evidence and the anecdotes and intuition take two forms: (1) reasons the empirical studies to date have been done wrong, and (2) reasons why one should not expect to find a significant effect of those regulations.

Some have suggested that regulations are not nearly as important to industrial location decisions as local public opposition to new plants (Gladwin and Welles, 1976). Few U.S. oil companies expanded their East Coast refining capacity in the 1970s, and Dow Chemical dropped plans to build a large petrochemical plant in Solano, California in 1977, in large part because of local public protests and the resulting delays (Chapman and Walker, 1991). This implies that the empirical studies of industrial flight



have mistakenly focused on the regulations and their compliance costs, when they should have concentrated on public environmental sentiment as a determinant of industry location. Hamilton (1993) included voting participation in a model of hazardous waste dump siting, and found that communities with higher participation were less likely to have dumps located there. Perhaps a similar variable is missing from the models of industrial site choice reviewed here. On the other hand, Gladwin and Welles (1976) discuss a sample of 50 cases of conflict between local environmental activists and multinational corporations seeking to open a new facility and find that most projects are merely delayed, not cancelled, as a result of public protest. A spokesperson for one U.S.-based oil refinery claimed that its policy was to fight for its chosen location despite local opposition, and that it usually won such battles. When it did not, the firm's response was to search for another site within the same country because market proximity, transport costs, and political risks outweigh environmental considerations (Walter, 1982).

Others have suggested that corporations doing business in a variety of jurisdictions find it most cost-effective to operate according to the most stringent regulations. This eliminates the necessity of designing different production processes for each location. Gladwin and Welles (1976) examine many environmental policies of multinational corporations. Most then merely vowed to obey local standards. Even those few companies claiming to have global policies, such as Dow Chemical's "Global Pollution Control Guidelines," modified their policies in the face of different local situations. Yet, as Gladwin and Welles note, in several cases companies use worldwide processes or technologies that meet the most stringent standards, despite local laws, and that in those cases cost savings rather than corporate environmental policy generated the uniformity. Knögden (1979) found that 90 percent of the West German firms she surveyed claimed to use the same environmental protection measures in developing countries as they did in West Germany, mostly for efficiency reasons. In a similar vein, the Economist magazine notes that the number of American chemical manufacturers following procedures more strict than those required by local legislation increased significantly after the Union Carbide accident in Bhopal, India. If it is true that multinational corporations comply with company-wide environmental practices, it

would explain their lack of sensitivity to local regulations and would weaken the arguments of those advocating international harmonization of environmental laws.

Cropper and Oates (1992) conclude that there has been no measurable industrial flight because environmental compliance costs are too small, relative to other costs, and too similar across countries to weigh heavily in location decisions. They conclude that "from an environmental perspective, this is a comforting finding, for it means that there is little force to the argument that we need to relax environmental policies to preserve international competitiveness." Yet the EPA (1990) has estimated that environmental control costs amount to 2 percent of U.S. GNP, and expects them to grow much larger in the future. It seems feasible that these growing costs could divert investment abroad, unless they are similar across countries. This latter argument takes several forms. Environmentalists have expressed fears that free trade agreements will "homogenize the world's laws at the common denominators which gigantic transnational corporations find comfortable."<sup>xxii</sup> Others believe that most countries are just a few short years (less than the lifetime of a factory) behind the U.S. in environmental standard stringency, and that multinational corporations would rather invest now than be forced to retrofit later. Globerman (1993) claims, for example, that "the experience of the EC suggests that when environmental standards differ across countries, convergence of standards will ultimately take place in the direction of the more restrictive set of standards." And one New York bank's chemical industry analyst claimed that "everywhere the clock is ticking; Even countries that seem not to care about pollution control now probably will have very strict rules long before [a new] plant has been on line for even half its 30 or 40 years lifetime" (Leonard and Duerksen, 1980). If it is correct that national environmental standards are naturally harmonizing at a stringent level, then one would expect that foresighted multinational corporations might not seek short-term gains from locating in temporarily less stringent jurisdictions.

Various other explanations for the discrepancy between public rhetoric and the lack of economic evidence abound. Pearson (1987) suggests that environmental regulations in developing countries promote, rather than deter, foreign direct investment. Multinational corporations have a superior ability

to comply with those regulations than do domestic corporations, due to their experience in jurisdictions with more stringent laws. As an example, he suggests that multinational corporations have more expertise and ability in preventing and containing oil spills than domestic producers. Walter (1982) suggests that one reason there may be no effect of environmental compliance costs on location of industry is that large pollution-intensive industry tends to exist in oligopolistic markets. If one believes that oligopolistic firms do not maximize profits, or are not as sensitive to competitive pressures, then this argument makes sense. It may also be that industries that are pollution intensive also happen to be relatively less footloose. Such industries are often more energy, transportation, capital, and technology-intensive, and if any of these considerations dominates the environmental compliance costs then firms will appear insensitive to such costs. Finally, I would argue that there is a cynical but compelling explanation for public officials' concern about the link between environmental regulations and competitiveness despite the dearth of evidence for such a link. Politicians receive support from many sources, including industry groups using pollution-intensive production processes. One convenient and inherently credible way of justifying favorable treatment for these polluting industries is to argue that regulations threaten their competitive position and that those industries might be forced to relocate.

Whatever the reason, there remains a large gap between the popular perception that environmental regulations harm competitiveness and the lack of economic evidence to support that perception. I suspect that the existing literature cannot convince policy makers or the public that links between environmental regulations and industrial location are insignificant, and that the gap between this literature and the conventional wisdom will continue to foster attempts to measure those links empirically.

**Table 4: Studies of industrial location and environmental regulations in the U.S.  
using establishment-level data and the conditional logit model.**

Independent Variables	Bartik (1988) Fortune 500 Branches by State		McConnell/Schwab (1990) Vehicle Assembly Plants by County		Freidman, et. al. (1992) Foreign MNCs by State		Levinson (1994) Branch Plants of Large Firms by State	
Environ- mental stringency	State air pollution spending	0.150+ (0.088)	County below national air quality stds.	0.512 (0.492)	Aggregate pollution abatement \$ / State GDP	-0.018 (0.055)	Number of regulations	-0.009+ (0.005)
	State water pollution spending	0.007 (0.085)					State monitoring effort	-0.099 (0.073)
							Industry-specific abatement costs	-0.501* (0.252)
Taxes	1-corporate tax	6.21* (1.89)	State tax	-0.157+ (0.084)	Tax receipts / population	-1.448* (0.225)	1-corporate tax	0.797 (1.699)
	Property tax	-0.578 (0.378)	County property tax	-4.367 (5.132)	Promotional \$	0.440* (0.044)		
Labor	Wage	-0.161 (0.350)	Wage	0.056 (0.145)	Wage	-1.854* (0.449)	Wage	0.122 (0.350)
	% Union	-4.10* (0.795)	% Union	-0.025 (0.042)	% Union	0.390* (0.126)	% Union	-1.058* (0.377)
	Education	-1.21 (1.00)			Productivity	0.722* (0.352)		
	UI tax rate	5.14 (13.89)			Unem- ployment	0.570* (0.183)		
	Workers compensation	0.992 (2.36)						
Market Access/size	Roads	0.566* (0.202)	Urban	1.344* (0.422)	Port	0.819* (0.107)	Roads	0.364* (0.127)
	Population density	-0.303 (0.205)	Demand	2.169 (4.725)	Demand	0.423* (0.040)		
	Existing manufacturing	0.956* (0.181)	State production wkrs	0.005+ (0.003)			Existing manufacturing	1.028* (0.052)
	Land area	1.02* (0.07)	County production wkrs	0.017* (0.006)				
Other Costs	Energy prices	-0.208 (0.254)	Energy prices	0.091 (0.276)			Energy prices	-0.013 (0.281)
	Construction costs	3.11* (1.07)						
Region	West	0.621* (0.202)	West	1.262 (1.319)			West	0.547* (0.108)
	South	0.297 (0.188)	South	-0.011 (0.883)			South	0.818* (0.120)
	Northeast	-0.047 (0.124)	Midwest	0.257 (0.943)			Midwest	0.603* (0.097)
Number of plants		1607			50	884	1648	

Standard errors in parentheses.

\* Statistically significant at 5%.

+ Statistically significant at 10%.

## NOTES



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i. David Byrne, environmental officer of Dublin Corporation, quoted in Leonard (1988).

ii. See Wilson's contribution to this volume for a summary of this literature. Wilson shows that interjurisdictional competition does not necessarily result in a "race to the bottom" with inefficiently lax standards. In theory, it can just as easily lead to the "NIMBY" phenomenon, with inefficiently stringent standards.

iii. It only matters in a general equilibrium sense, because if the state subsidizes cleanup, then being a member of a polluting industry becomes more profitable, firms will enter the industry, and the long-run equilibrium can include more pollution than before subsidization.

iv. Selected Environmental Law Statutes. West Publishing: St. Paul, MN, 1994.

v. The U.S. signed two multilateral environmental treaties between 1940 and 1959, ten from 1960 to 1979, and 11 during the 1980s (Economist, May 30, 1992).

vi. New York Times, October 8, 1980, cited in Leonard (1988).

vii. Environment Reporter, Vol. 9, No. 10, (Jul 7, 1978), p.451, cited in Leonard and Duerksen (1980).

viii. New York Times, May 23, 1993.

ix. Not to be outdone, the U.S. Commerce Department publishes a biweekly newsletter called NAFTA News full of stories about U.S. companies increasing their exports to Mexico.

x. The process of painting or staining wood furniture releases volatile organic compounds (VOCs), precursors to ozone (smog). Los Angeles has been steadily tightening its control of VOC sources in an attempt to meet national ambient air quality standards. Wood furniture manufacturers have been required to reduce emissions by 93 percent, incrementally as of 1989, 1990, 1994 and 1996. Manufacturers claim to be uncertain that they can meet the most stringent requirements.

xi. Best estimate, due to an apparent typographical error in Knögdén (1979).

xii. Walter's study relied on data from the late 1960s, which may have been too soon to pick up the effect of early U.S. environmental regulations. Robison examines data from 1973, 1977, and 1982.

xiii. The only attempt to quantify countries' environmental stringency has been shown to be roughly inversely related to per capita income (Walter and Ugelow, 1979).

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xiv. The trade policy index is due to Dollar (1990), and was developed for the World Bank's 1991 World Development Report. It simply ranks countries from one (open) to seven (closed).

xv. Clearly any such index has its faults, but the UNCTAD index is the only international index of environmental regulatory stringency I have located. Senator Boren's Pollution Deterrence Act of 1991, had it passed, would have required the U.S. EPA to construct an "International Pollution Control Index" for the top 50 trading partners of the U.S. This index would compare each country's pollution control standards to those in the U.S. Although the bill failed to indicate how the EPA was to accomplish this difficult task, many of the empirical studies discussed here would have found such an index extremely useful.

xvi. ABC Documentary "The Killing Grounds," 1979.

xvii. "Raising Business Costs," Journal of Commerce and Commercial October 16, 1991.

xviii. Unfortunately, by the late 1980s Alexander Grant had stopped including environmental control costs on its list of location influences.

xix. There are many acknowledged problems with these data. Both Schmenner (1982) and McConnell and Schwab (1990) cross-checked their extracts of the Dun & Bradstreet data carefully, and found problems with many of the observations. Crandall (1993) notes that the Dun & Bradstreet data have difficulty distinguishing plant births and deaths from sales and acquisitions.

xx. Their explanation of this regulatory stringency variable is that out-of-compliance counties will enforce stricter standards in an effort to comply. It is possible, of course, that the effect works in the other direction, that cities with lax regulations exceed federal ambient air quality standards.

xxi. McConnell and Schwab's choice of industry may have been unfortunate, if vehicle assembly plants are not geographically footloose.

xxii. Sierra Club advertisement in the New York Times, June 20, 1994, p. A5.